

# Study on new energy development planning and absorptive capability of Xinjiang in China considering resource characteristics and demand prediction

Hai Shao<sup>1</sup>, Xujuan Miao<sup>1</sup>, Jinpeng Liu<sup>2,3</sup>, Meng Wu<sup>1</sup> and Xuehua Zhao<sup>1</sup>

<sup>1</sup>Economy and Technology Research Institute, State Grid Xin Jiang Electric Power Corporation, Wulumuqi 830011, China

<sup>2</sup>School of Economics and Management, North China Electric Power University, Beijing 102206, China

<sup>3</sup>hbdlljp@163.com

**Abstract.** Xinjiang, as the area where wind energy and solar energy resources are extremely rich, with good resource development characteristics, can provide a support for regional power development and supply protection. This paper systematically analyzes the new energy resource and development characteristics of Xinjiang and carries out the demand prediction and excavation of load characteristics of Xinjiang power market. Combining the development plan of new energy of Xinjiang and considering the construction of transmission channel, it analyzes the absorptive capability of new energy. It provides certain reference for the comprehensive planning of new energy development in Xinjiang and the improvement of absorptive capacity of new energy.

## 1. Introduction

Xinjiang is located in the northwest of China, with a vast territory, rich energy reserves and other significant features. In recent years, the new energy development and construction speed is gradually accelerating, which provides certain support for the regional power supply and long-distance energy transport. Due to the relatively small demand for electricity and load in Xinjiang, the absorptive capacity of new energy resource development area is limited. So it has a certain effect on the development of new energy in Xinjiang. Accelerating the development of new energy resource, enhancing cross-regional transport capacity and ensuring the full utilization of energy are receiving wide attention.

Combining the characteristics of new energy development in Xinjiang, Huang Bo[1] puts forward some suggestions on how to optimize the development of new energy industry in Xinjiang; Considering the strategic position of new energy development and utilization, XuKe[2] puts forward some suggestions on how to enhance the development strategy height; Taking Xinjiang as an example, Wang Di [3] analyzes the comprehensive benefits of the development of new energy and the use of traditional capacity; Combining with the development demand that the new energy of Xinjiang accesses to the northwest power grid, Sun Yujiao[4] researches the transportation capacity and safety of network channels of Xinjiang; Combining with the development status of new energy source in recent years in Xinjiang, Qin Chunyan[5] analyzes the industrial development problems and solutions. To a certain extent, the related literature results can be used to research the development problems of new energy in Xinjiang, but it lacks the consideration that systematically combines the characteristics



and development demands of new energy resource in Xinjiang. The development planning and the analysis of absorptive capacity of new energy still need to continue to strengthen.

## **2. Development characteristics and problems analysis of new energy in Xinjiang**

### *2.1. Analysis of wind energy resource and development characteristics in Xinjiang*

Xinjiang wind energy resource is extremely rich, which is one of the most abundant provinces in China. According to the "China Wind Energy Resource Assessment Report", the total reserves of Xinjiang wind energy resource is 890 million kW, which accounts for 20.4% of China and ranks the second in China. The wind energy resource which can be developed and used concentrated in the nine wind areas. The area of nine wind areas is 77,800 square kilometers, the average annual wind power density are more than 150W / square meter, the annual effective wind speed time are 5600 ~ 7300 hours and the technical exploitable amount is 120 million kW. The quality of wind energy is good, the wind frequency distribution is reasonable and the destructive hurricanes are very few. It has excellent wind energy resource conditions which can be used to construct the large-scale wind farms.

### *2.2. Analysis of solar energy resource and development characteristics in Xinjiang*

The annual sunshine time is longer, the sunshine percentage is 60 ~ 80%, the days that their sunshine time are 6 hours or more are 250 ~ 325, the total sunshine hours are 2550 ~ 3500 hours, Annual solar radiant illumination is 5.5~ 6.6 million kilojoule / square meter and the annual average is 580 joule / square meter in Xinjiang, which ranks the second in China and has great potential for resource development. The peak solar energy in Xinjiang is located in the eastern of Xinjiang and the east of southern of Xinjiang and the low value appears in some areas of Bozhou, Altai and north of the Tianshan mountain. The regional distribution of annual total radiant illumination is roughly decreasing from southeast to northwest and the direct radiation peak point is generally distributed in Hami area. The distribution of solar energy resource in Xinjiang is as shown below.

Before 2030, solar energy is mainly based on utilization of heat and off-grid power generation and is mainly used in rural areas and communications electrification. After 2030, with the further maturity of solar power generation technology and the decline of equipment and material manufacturing cost, our country will large-scale develop the grid-connected solar power generation. They are mainly desert power stations, including photovoltaic power generation and thermal power generation, which are expected to rise and occupy a certain market share. It is mainly photovoltaic power generation and the thermal power generation also need more technology research and development and demonstration, such as improving the efficiency of solar condenser receiver, the development of advanced thermal storage technology and other key technologies and water supply problems. Its share is relatively small. By 2020, the installed capacity of solar power in Xinjiang is about 600-750MW and it is 2000-7000MW by 2030.

### *2.3. Analysis of the main problems of new energy development in Xinjiang*

Power grid backbone network is weak, the capacity of supporting large-scale power transmission is insufficient. The power grid runs too heavily on 750kV devices, so that many problems have appeared, such as equipment overload, transient instability, the reduction of transmission limit, complex control measures and so on. It caused great security risk.

Uneven distribution of resource and power infrastructure in southern of Xinjiang is weak. Because the energy resource of Xinjiang is mainly distributed in northern of Xinjiang. The installed capacity of power generation of northern of Xinjiang accounts for more than 80% of Xinjiang and the thermal power accounted for more than 85% of Xinjiang. The main power flow of Xinjiang is sent from the northern to the southern of Xinjiang. In recent years, the electricity consumption in the southern of Xinjiang grew faster, but the main power supply capacity is small and the runoff type of small hydropower is more important than the other, resulting in seasonal power cut in the southern of

Xinjiang in recent years. It is necessary to speed up the further extension of the 750kV power grid to the southern of Xinjiang.

New energy projects developed too fast and it made a severe test for the power grid. During the "Twelfth Five-Year" period, with the construction of Xinjiang power grid to speed up, a large number of transmission and transformation equipment were put into operation and the scale of power grid was further expanded, so that the 220kV trunk grid had been greatly strengthened and the transmission scale to the northwest main network was further increased, so the power supply reliability had been effectively improved. However, because the rapid development of new energy projects in Xinjiang had crossed the power grid construction speed, resulting in the power generation of new energy projects were limited.

### 3. Demand prediction and load characteristics analysis of Xinjiang electric power

#### 3.1. Prediction analysis of power demand development in Xinjiang

According to the national economic and social development planning of Xinjiang, combining with the actual growth of Xinjiang electric power load, the prediction analysis of power development of Xinjiang was carried out and it was divided into three development scenarios based on the electricity: high, medium, low. It was based on the analysis of the national economy, social development and electricity trend, as well as the impact of macroeconomic situation. On the basis of the prediction results, by analyzing the number and trend of load utilization and combining the load prediction results of large users, three development scenarios of high, medium and low based on the load were put forward, as shown in table 1.

**Table 1.** Full-caliber load and electricity prediction of Xinjiang.

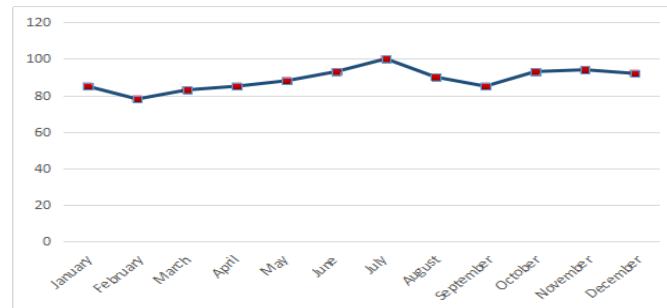
| Scenario   | 2017 | 2018 | 2020 | 2030  | The growth rate of Twelfth Five-Year | The growth rate of 2020-2030 |
|--|------|------|------|-------|--------------------------------------|------------------------------|
| Full-caliber electricity level (One hundred million kWh) |      |      |      |       |                                      |                              |
| High level   | 3096 | 3702 | 4645 | 14427 | 16.50%                               | 12.00%                       |
| Medium level   | 2841 | 3265 | 4114 | 10675 | 14.50%                               | 10.00%                       |
| Low level  | 2550 | 2880 | 3500 | 7560  | 12.50%                               | 8.00%                        |
| Full-caliber load level (10MW)                           |      |      |      |       |                                      |                              |
| High level   | 5562 | 6483 | 8787 | 27291 | 16.50%                               | 12.00%                       |
| Medium level   | 5443 | 6210 | 7826 | 20496 | 14.60%                               | 10.10%                       |
| Low level  | 4880 | 5470 | 6650 | 14500 | 12.60%                               | 8.10%                        |

According to the prediction results of the medium plan, the growth rate of electricity consumption of "Twelfth Five-Year" and "2020-2030" in Xinjiang are respectively 14.5% and 10% and the maximum load growth rate are respectively 14.6% and 10.1%.

#### 3.2. Analysis of power load characteristics in Xinjiang

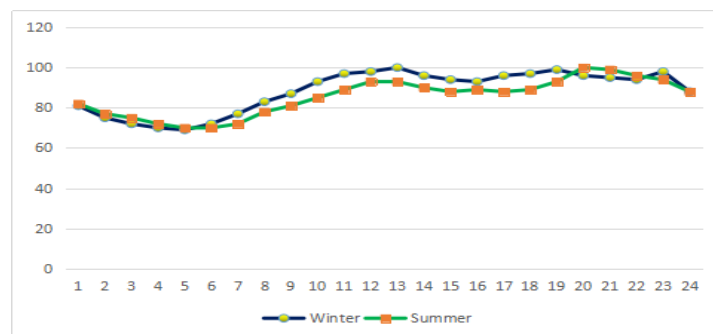
From the variation of load characteristics of the main power grid in Xinjiang in the past two years, the annual load changed slightly and the seasonal disequilibrium rate slightly decreased. There are two

peaks in summer and winter every year. The peak period of the annual load from the previous November - December winter heating period into July - August summer high temperature period. The typical annual load curve of power grid in Xinjiang is shown as figure 1.



**Figure 1.** The typical annual load curve of power grid in Xinjiang.

While the change of daily load is slowing down, the daily load rate and the daily minimum load rate have a certain range of rise. There are two load peak period in the summer typical day. The midday peak appears at 12:00-14:00 and the late peak appears at 21:00- 23:00. The maximum load appears at 18:00-21:00 and the second peak appears at 11:00-13:00 in the winter typical day. The typical daily load curve of power grid in Xinjiang is shown as figure 2.



**Figure 2.** The typical daily load curve of power grid in Xinjiang.

With the economic development of Xinjiang, the improvement of people's living standard, the increase of the proportion of high energy consumption industrial electricity, the improvement of electric power market mechanism and the application of demand side management means, it is expected that the annual load of Xinjiang's main power grid will change with the seasons. The seasonal disequilibrium rate will increase and the daily minimum load rate and daily disequilibrium rate will rise.

#### 4. Analysis of the development planning of new energy construction in Xinjiang

##### 4.1. The development planning of Hydropower construction

The theoretical reserves of water resource in Xinjiang is 38178.7MW, accounting for 5.6% of the total resource of china and ranking the fourth in China. The technology exploitable capacity is 16564.9MW, the annual power generation is 71.26 billion kWh, the economic exploitable quantity is 15670MW, the annual power generation is 68.28 billion kWh. The hydropower resource of Xinjiang is mainly concentrated in the Yili River Basin, the Irtys River Basin, the Kaidu River Basin and the Yarkand River Basin. The river has the largest theoretical reserves in Xinjiang is the Ili River and the total reserve is 7063MW. It can develop 38 power stations. The total installed capacity is 2548MW and the annual power generation is 9.82 billion kWh.

The most important feature of hydropower resource of Xinjiang is that the runoff is not changed year by year, which is consistent with the law of water supply of glaciers, but the runoff varies greatly with the seasons. The amount of water of the dry period in winter account for 10% ~ 20% of the wet period in summer. And the adjustment capacity of hydropower station in Xinjiang is poor, leading to the effectiveness of hydropower station in the dry period in winter is very low and generally accounts for 20%-30% of the installed capacity.

According to the principle of "orderly development of hydropower", considering the influencing factors, such as the resource of river basins, development and utilization conditions, agricultural irrigation of river basins, water diversion project construction and electricity market demand and so on, the development of water resource of Xinjiang in the future is mainly concentrated in Yili River, Kaidu River, Irtysh River, Yeer Qiang River and so on..

#### *4.2. Wind power construction and development planning*

Xinjiang is one of the provinces of China's windy region, due to its unique geographical environment, resulting in the different distribution of wind speed and wind direction. In general, the wind speed in the northern of Xinjiang is greater than that in the southern of Xinjiang, the wind speed in mountainous area is greater than that in basin. The wind speed in high mountains area is greater than that in middle and low mountainous area. The mountains area, canyon and valley are mostly areas with great wind speed. In particular, the average annual wind speed in the northern of Xinjiang and the tuyere and wind areas in the eastern of Xinjiang is above 6m / s and the wind speed of thirteen rooms is above 8m / s. The number of windy days are more than 100 days one year and Alashankou, Dabancheng and Thirteen rooms are up to 150 days or more. The maximum wind speed is more than 40m / s. Because the main power grid in Xinjiang has not yet extended to the Lop Nor wind area, the wind area recently do not have the conditions for large-scale development of wind power. The autonomous region development and reform commission of Xinjiang has approved the approval of the three typhoon wind area in Bozhou, the Loulan wind area in Turpan, the Mulei wind area in Huaidong and other wind area planning to make full use of the wind energy resource of Xinjiang. The technology exploitable capacity of the nine wind areosis considered as 120 million kW and plan to build to 25 million kW in 2018.

#### *4.3. Development planning of photovoltaic power generation*

The solar energy resource of Xinjiang is mainly distributed in the eastern of Xinjiang, the southern of Tianshan Mountain, the northern of the Tianshan Mountain and the middle part of the northern of Xinjiang. The eastern of Xinjiang has abundant resource. The resource of the southern of Tianshan Mountain is less than it. The northern of Tianshan Mountain is rich in resource and the middle and north parts of the northern of Xinjiang are sub rich zones of resource.

Solar photovoltaic power generation should adhere to the principles of the unified planning, rational layout, highlighting the key, orderly development. Taking the solar photovoltaic power generation projects construction as the key and the solar thermal power generation is promoted moderately. The rooftop solar grid-connected photovoltaic power generation facilities are demonstrated and popularized. Solar energy generation should follow the following principles: (1) The key is to use the desertification land resource to carry out the construction of photovoltaic base in the southern and northern of Xinjiang which have rich solar energy resource and to construct the distributed photovoltaic power station in the sites which have good resource conditions and is suitable for decentralized access. (2) According to the development idea of "solar power park", following the principle of "unified construction and phased planning", our country should construct the solar power park in the areas where the solar energy resource is abundant, the transportation is convenient, the use conditions of land are better and the access conditions of the power grid are better. (3) To consider other the end of the power grid areas have good resource, and construct the distributed solar photovoltaic power plants. (4) It is necessary to properly plan off-grid photovoltaic power plants in the remote areas of the southern of Xinjiang where the traffic is inconvenience, the living is scattered, the

power grid can not be extended there and solve the life electricity problems of local population. According to the development of solar photovoltaic industry in Xinjiang, combining with the future trend of declining electricity price ,it is expected to reach 7790 MPa in 2018.

## 5. Analysis of absorptive capacity of new energy of Xinjiang considering the construction of outbound channel

### 5.1. The construction of outbound channel and planning analysis of the power grid of Xinjiang

According to the overall planning of the China National Grid Corporation, the construction scale and process arrangement of outbound channel of Xinjiang are shown as table 2.

**Table 2.** The construction scale and process arrangement of outbound channel of Xinjiang Unit:10MW.

| Serial number | Project   | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---------------|---|------|------|------|------|------|------|
| First         | External power transmission of Xinjiang   | 400  | 600  | 1300 | 2300 | 3100 | 3100 |
| 1             | The external power transmission of 750kV alternating current from Xinjiang to northwest | 200  | 200  | 500  | 500  | 500  | 500  |
| 2             | The $\pm 800$ kV direct-current project from Hami to Zhengzhou                          | 200  | 400  | 800  | 800  | 800  | 800  |
| 3             | The $\pm 1100$ kV direct-current project from Huaidong to east of China                 |      |      |      | 1000 | 1000 | 1000 |
| 4             | The $\pm 800$ kV direct-current project from the north of Hami to Chongqing             |      |      |      |      | 800  | 800  |

**Table 3.** The new energy installed capacity can be accepted by the power grid of Xinjiang Unit: 10MW

|        | Project   |              | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|--------|---|--------------|------|------|------|------|------|------|
| First  | The planning of new energy installation               |              | 778  | 1340 | 1987 | 2370 | 2545 | 2620 |
| Second | The absorptive of new energy installation             | Big summer   | 903  | 1489 | 2422 | 2675 | 3665 | 3877 |
|        |   | Small winter | 268  | 742  | 1307 | 1389 | 2092 | 2177 |
| 1      | The absorptive of new energy installation of Xinjiang | Big summer   | 843  | 1033 | 1497 | 1750 | 2247 | 2459 |
|        |   | Small winter | 208  | 286  | 382  | 464  | 674  | 759  |
| 2      | The new energy delivery                               |              | 60   | 456  | 925  | 925  | 1418 | 1418 |
| Third  | Profit and loss                                       | Big summer   | 125  | 149  | 435  | 305  | 1120 | 1257 |
|        |   | Small winter | -510 | -598 | -680 | -981 | -453 | -443 |



Three UHV DC outbound channels will be built by the power grid of Xinjiang until 2018. Among them, the  $\pm 800\text{kV}$  direct-current project from Hami to Zhengzhou was unipolar put into operation in 2013 and its delivery capacity is 4000MW. The project was bipolar put into operation in 2014 and its delivery capacity is 8000MW. The  $\pm 1100\text{kV}$  direct-current project from Huaidong to east of China was bipolar put into operation in 2016 and its delivery capacity is 10,000MW. The  $\pm 800\text{kV}$  direct-current project from the north of Hami to Chongqing will be put into operation in 2017 and its delivery capacity is 8000MW.

### 5.2. Analysis of absorptive capacity of new energy of power grid of Xinjiang

In summary, considering the peak load capacity of Xinjiang and the direct-current delivery of new energy projects, the development of new energy installed capacity can be accepted by the power grid of Xinjiang is shown in the table 3.

According to the analysis result of acceptance capacity of wind power installed capacity of the power grid of Xinjiang shown in the above table, the acceptable installed capacity of new energy of Xinjiang based on the big summer way is about 14890MW~38770MW and the acceptable installed capacity of new energy of Xinjiang based on the small winter way is 7420MW~21770MW after considering the direct-current delivery from 2014 to 2018. The installed capacity of new energy planning of Xinjiang in the present is about 13400MW~26200MW. Therefore, the surplus acceptance installed capacity of new energy of Xinjiang based on the summer big way is 1490MW~12570MW.

## 6. Summary

The rational development and utilization of new energy resource in Xinjiang can provide a reliable guarantee for supporting the regional economic development and ensuring the power supply. Combining with the characteristics of new energy resource and the regional power demand prediction analysis of Xinjiang, it can provide reference for carrying out the new energy construction and development planning and for the construction of outbound channels and the analysis of absorptive capacity. In the future, with the rapid development of high voltage, long distance and large capacity transmission technology, regional energy structure adjustment and energy storage technology, the new energy development of Xinjiang will get all-round support and guarantee and has good development potential.

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